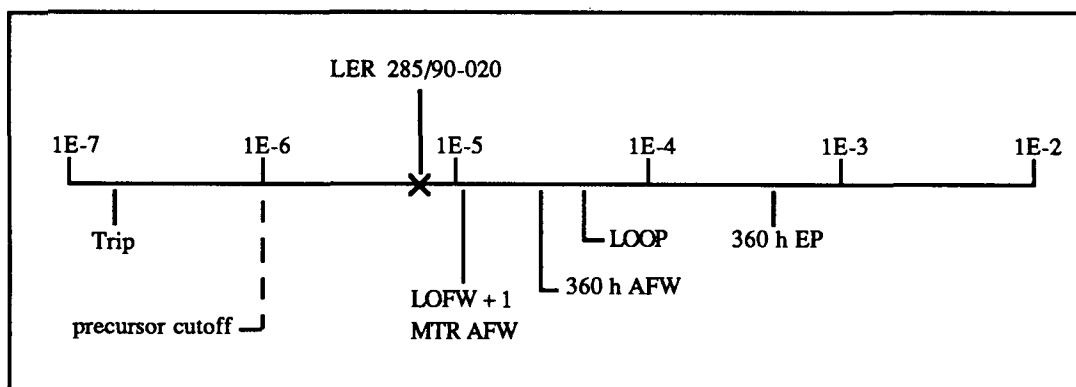


ACCIDENT SEQUENCE PRECURSOR PROGRAM EVENT ANALYSIS

LER No.: 285/90-020
 Event Description: EDG failure, similar condition with other EDG
 Date of Event: September 13, 1990
 Plant: Fort Calhoun

Summary

High ambient air temperatures resulted in failure of an emergency diesel generator (EDG) during a performance test. Electronic components of the generator's voltage regulator were located in an unvented cabinet. After 2 h of operation, these components overheated and failed. The other EDG was not subjected to a similar test but was identically configured. The conditional probability of core damage associated with this event is 6.5×10^{-4} . The relative significance of the event compared to other postulated events at Fort Calhoun is shown below.



Event Description

Approximately 2 h into a test run of EDG 1, generator output current increased from a normal operating level of 385 amp to 575 amp. Operators attempted to reduce the generator output but were unsuccessful. When they opened the generator output breaker, the generator output voltage dropped to 2120V-AC, about one-half of normal. Operators then shut down the EDG and declared it inoperable.

An investigation into the failure determined that components in the generator exciter circuit had overheated and failed. These components were located in an unvented cabinet in the room with the EDG. Ambient air temperature was elevated and temperatures as

high as 140°F were measured on the surface of the exciter cabinet. This was judged sufficiently high to cause semiconductor components of the exciter system to fail. An identical design problem was identified on the other EDG.

Additional Event-Related Information

Two diesel generators at Fort Calhoun are intended to provide AC power to vital equipment in the event of a loss of offsite power (LOOP). In the event of a LOOP and coincident failure of the EDGs, two batteries can provide instrumentation and control power for a period of up to 8 h. There is one turbine-driven auxiliary feedwater pump, which can provide water to the steam generators to remove decay heat during this time.

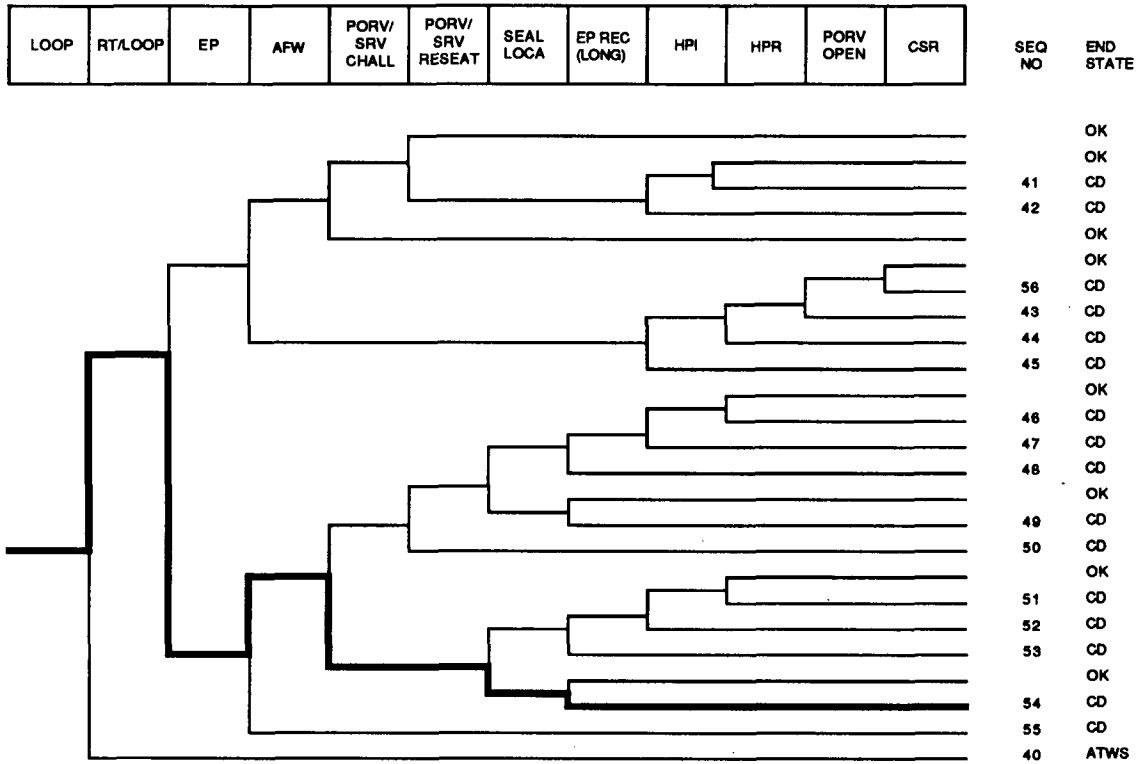
ASP Modeling Assumptions and Approach

The event has been modeled as a potential LOOP with both EDGs unavailable after 2 h. A frequency of 0.012/reactor year was assumed for a LOOP with a duration greater than 2 h (see ORNL/NRC/LTR-89/11, *Revised Loop Recovery and Seal LOCA Models*, August 1989). A period of vulnerability of 0.2 yr was assumed, since it is believed that high ambient temperatures were a necessary contributor to the EDG failure.

The contributions of core damage probability of seal failure sequences were neglected in this analysis as they are accounted for in another analysis. LER 285/90-025 details a finding that, as a result of design deficiencies, a loss of instrument air would result in a failure of the component cooling water (CCW) system. As CCW cools the charging pumps, they are also considered to be rendered inoperable by a loss of instrument air. Failure of both CCW and charging would place the reactor coolant pump (RCP) seals at risk. These failures could be expected during any LOOP, and the associated risks related to seal failures are considered in the analysis for 285/90-025.

Analysis Results

The probability of a LOOP greater than 2 h in duration is about $2 \times 10^{-6}/\text{h}$. The probability of such a LOOP over a 0.2-yr period (~ 1226 critical h) is therefore 0.0024. With the EDGs assumed unavailable, recovery requires restoration of offsite power in the long term (nonrecovery probability, $p = 0.256$). The conditional core damage probability estimated for this event is 6.4×10^{-4} . The dominant core damage sequence is highlighted on the following event tree. This sequence involves a LOOP with a duration greater than 2 h, emergency power system failure, and failure to recover AC power prior to battery depletion.



Dominant core damage sequence for LER 285/90-020

B-164

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 285/90-020
 Event Description: EDGs unavailable under high ambient temperatures
 Event Date: 09/13/90
 Plant: Fort Calhoun

UNAVAILABILITY, DURATION= 6132

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

LOOP	2.4E-03
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SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
LOOP	6.5E-04
Total	6.5E-04

ATWS

LOOP	0.0E+00
Total	0.0E+00

SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

	Sequence	End State	Prob	N Rec**
54	LOOP -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall - SEAL.LOCA EP.REC	CD	5.9E-04	1.2E-01
55	LOOP -rt/loop EMERG.POWER afw/emerg.power	CD	3.9E-05	4.1E-02
49	LOOP -rt/loop EMERG.POWER -afw/emerg.power porv.or.srv.chall - porv.or.srv.reseat/emerg.power -SEAL.LOCA EP.REC	CD	2.4E-05	1.2E-01

** non-recovery credit for edited case

SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

	Sequence	End State	Prob	N Rec**
49	LOOP -rt/loop EMERG.POWER -afw/emerg.power porv.or.srv.chall - porv.or.srv.reseat/emerg.power -SEAL.LOCA EP.REC	CD	2.4E-05	1.2E-01
54	LOOP -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall - SEAL.LOCA EP.REC	CD	5.9E-04	1.2E-01
55	LOOP -rt/loop EMERG.POWER afw/emerg.power	CD	3.9E-05	4.1E-02

** non-recovery credit for edited case

Note: For unavailabilities, conditional probability values are differential values which reflect the added risk due to failures associated with an event. Parenthetical values indicate a reduction in risk compared to a similar period without the existing failures.

SEQUENCE MODEL: c:\asp\1989\pwrqseal.cmp
 BRANCH MODEL: c:\asp\1989\calhoun.sll
 PROBABILITY FILE: c:\asp\1989\pwr_bsll.pro

Event Identifier: 285/90-020

B-165

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	6.0E-05	1.0E+00	
LOOP	1.6E-05 > 3.3E-06	5.3E-01 > 1.2E-01	
Branch Model: INITOR			
Initiator Freq:			
loca	1.6E-05 > 3.3E-06		
rt	2.4E-06	4.3E-01	
rt/loop	2.8E-04	1.2E-01	
EMERG.POWER	0.0E+00	1.0E+00	
	2.9E-03 > 1.0E+00	8.0E-01 > 1.0E+00	
Branch Model: 1.OF.2			
Train 1 Cond Prob:	5.0E-02 > Failed		
Train 2 Cond Prob:	5.7E-02 > Failed		
afw	2.3E-03	2.6E-01	
afw/emerg.power	5.0E-02	3.4E-01	
mfw	2.0E-01	3.4E-01	
porv.or.srv.chall	4.0E-02	1.0E+00	
porv.or.srv.reseat	2.0E-02	1.1E-02	
porv.or.srv.reseat/emerg.power	2.0E-02	1.0E+00	
SEAL.LOCA	4.6E-02 > 0.0E+00 **	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	4.6E-02		
EP.REC(SL)	5.7E-01 > 0.0E+00 **	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	5.7E-01		
EP.REC	1.4E-02 > 2.6E-01 **	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	1.4E-02		
hpi	1.0E-03	8.4E-01	
hpi(f/b)	1.0E-03	8.4E-01	1.0E-02
porv.open	1.0E-02	1.0E+00	4.0E-04
hpr/-hpi	1.5E-04	1.0E+00	
csr	2.0E-03	3.4E-01	
* branch model file			
** forced			

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08-06-1991

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Event Identifier: 285/90-020